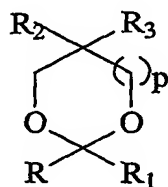


Claims

What is claimed is:

1. A method for enhancing a chemical reaction of a molecule comprising contacting
5 the molecule with a surfactant represented by formula I:



(I)

in which

p is 0, 1 or 2;

R is alkyl;

- 10 R₁ and R₂ are each, independently, hydrogen or methyl; and
R₃ is selected from -OSO₃⁻, -R₄OSO₃⁻, -R₄OR₅SO₃⁻, and -OR₅SO₃⁻,
wherein R₄ and R₅ are each, independently, lower alkyl;
to thereby enhance the chemical reaction of the molecule.

- 15 2. The method of claim 1, wherein the molecule is a biomolecule.

3. The method of claim 2, further comprising analyzing the biomolecule following the chemical reaction.

- 20 4. The method of claim 2, wherein the biomolecule is contained in a biological sample.

5. The method of claim 4, wherein the biological sample is selected from the group consisting of inclusion bodies, biological fluids, biological tissues, biological matrices,
25 embedded tissue samples, and cell culture supernatants.

6. The method of claim 2, wherein the biomolecule is selected from the group consisting of a protein and a peptide.

- 30 7. The method of claim 6, wherein the biomolecule is selected from the group consisting of a lipophilic protein, a receptor, a proteolytic protein, and a membrane-bound protein.

8. The method of claim 3, wherein the analysis is selected from the group consisting of solid phase extraction, solid phase micro extraction, electrophoresis, mass spectrometry, liquid chromatography, liquid-liquid extraction, membrane extraction, soxhlet extraction, precipitation, clarification, electrochemical detection, staining, elemental analysis, Edmund degradation, nuclear magnetic resonance, infrared analysis, flow injection analysis, capillary electrochromatography, ultraviolet detection, and combinations thereof.
9. The method of claim 8, wherein the mass spectrometry is surface desorption ionization mass spectrometry.
10. The method of claim 9, wherein the surfactant is not degraded prior to analysis.
11. The method of claim 9, wherein the surfactant is degraded prior to analysis.
12. The method of claim 1, wherein the reaction comprises chemical digestion, chemical alteration, or a combination thereof.
13. The method of claim 12, wherein the reaction comprises chemical digestion.
14. The method of claim 13, further comprising contacting the biomolecule with a protease, CNBr, or hydroxylamine.
15. The method of claim 13, further comprising separating the resulting biomolecule fragments.
16. The method of claim 14, wherein the protease is immobilized.
17. The method of claim 14, wherein the protease is selected from the group consisting Trypsin, Chymotrypsin Lys-C, Glu-C (V8 protease), AspN, Arg-C, S. Aureus, Clostripain, Pepsin, and Papain.
18. The method of claim 9, wherein the reaction comprises chemical alteration.
19. The method of claim 18, wherein the chemical alteration is selected from the group consisting of alkylation, reduction, and a combination thereof.

20. The method of claim 1, wherein the enhancement of the chemical reaction comprises a favorable chemical property.

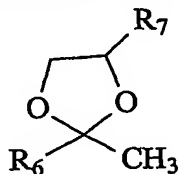
21. The method of claim 20, wherein the favorable chemical property is selected from the group consisting of a more complete reaction, increased efficiency, increased yield, increased rate, and increased utility.

22. The method of claim 12, wherein the chemical reaction comprises denaturing the biomolecule, solubilizing the biomolecule, or a combination thereof.

23. The method of claim 1, further comprising degrading the surfactant after the chemical reaction.

24. The method of claim 23, wherein the surfactant is degraded by contact with an acidic solution.

25. The method of claim 1, wherein the surfactant is represented by formula II:



(II)

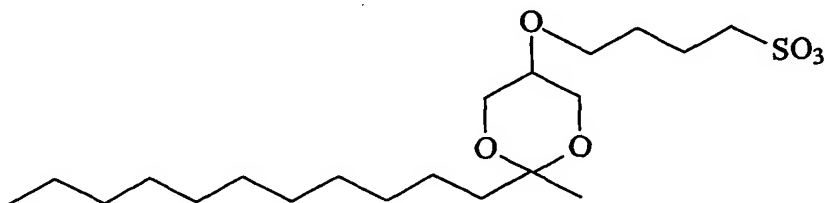
in which

R₆ is alkyl;

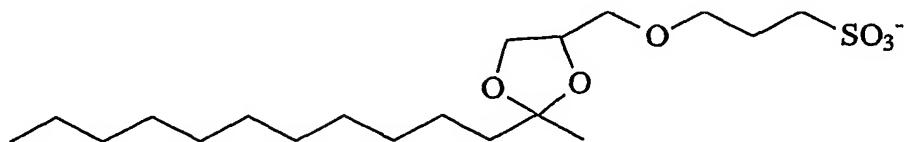
R₇ is selected from -OSO₃⁻, -R₄OSO₃⁻, -R₄OR₅SO₃⁻, and -OR₅SO₃⁻,

wherein R₄ and R₅ are each, independently, lower alkyl.

26. The method of claim 1 wherein the surfactant has the following chemical structure:



27. The method of claim 1 wherein the surfactant has the following chemical structure:



5

28. The method of claim 1 wherein the enhancement of the chemical reaction facilitates on-line automation, separation, mass spectrometric analysis, or a combination thereof.

10 29. The method of claim 1 wherein the chemical reaction is performed under microscale conditions.

30. The method of claim 13 wherein the digestion occurs in an electrophoretic gel.

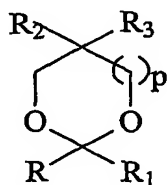
15 31. The method of claim 30 wherein the digestion occurs in the presence one or more surfactants that are different from the surfactant in Formula I.

32. The method of claim 31 wherein the digestion occurs in the presence of SDS.

20 33. The method of claim 31 wherein the digestion occurs in the absence of SDS.

34. A method for analysis of a biomolecule comprising: enhancing a chemical reaction of the biomolecule by contacting a sample containing the biomolecule with a surfactant represented by the formula:

25



in which

p is 0, 1 or 2;

R is alkyl;

R_1 and R_2 are each, independently, hydrogen or methyl; and
 R_3 is selected from $-\text{OSO}_3^-$, $-\text{R}_4\text{OSO}_3^-$, $-\text{R}_4\text{OR}_5\text{SO}_3^-$, and $-\text{OR}_5\text{SO}_3^-$,
wherein R_4 and R_5 are each, independently, lower alkyl; and
analyzing the sample; to thereby analyze the biomolecule.

5

35. The method of claim 34, wherein the molecule is a biomolecule.

36. The method of claim 35, further comprising analyzing the biomolecule following the chemical reaction.

10

37. The method of claim 35, wherein the biomolecule is contained in a biological sample.

15

38. The method of claim 37, wherein the biological sample is selected from the group consisting of inclusion bodies, biological fluids, biological tissues, biological matrices, embedded tissue samples, and cell culture supernatants.

39. The method of claim 35, wherein the biomolecule is selected from the group consisting of a protein and a peptide.

20

40. The method of claim 39, wherein the biomolecule is selected from the group consisting of a lipophilic protein, a receptor, a proteolytic protein, and a membrane-bound protein.

25

41. The method of claim 36, wherein the analysis is selected from the group consisting of solid phase extraction, solid phase micro extraction, electrophoresis, mass spectrometry, liquid chromatography, liquid-liquid extraction, membrane extraction, soxhlet extraction, precipitation, clarification, electrochemical detection, staining, elemental analysis, Edmund degradation, nuclear magnetic resonance, infrared analysis, flow injection analysis, capillary electrochromatography, ultraviolet detection, and combinations thereof.

30

42. The method of claim 41, wherein the mass spectrometry is surface desorption ionization mass spectrometry.

35

43. The method of claim 42, wherein the surfactant is not degraded prior to analysis.

44. The method of claim 34, wherein the reaction comprises chemical digestion, chemical alteration, or a combination thereof.

45. The method of claim 44, wherein the reaction comprises chemical digestion.

46. The method of claim 45, further comprising contacting the biomolecule with a protease, CNBr, or hydroxylamine.

47. The method of claim 45, further comprising separating the resulting biomolecule fragments.

48. The method of claim 46, wherein the protease is immobilized.

49. The method of claim 46, wherein the protease is selected from the group consisting Trypsin, Chymotrypsin Lys-C, Glu-C (V8 protease), AspN, Arg-C, S. Aureus, Clostripain, Pepsin, and Papain.

50. The method of claim 42, wherein the reaction comprises chemical alteration

51. The method of claim 50, wherein the chemical alteration is selected from the group consisting of alkylation, reduction, and a combination thereof.

52. The method of claim 34, wherein the enhancement of the chemical reaction comprises a favorable chemical property.

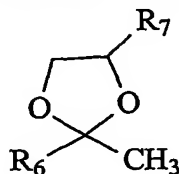
53. The method of claim 52, wherein the favorable chemical property is selected from the group consisting of a more complete reaction, increased efficiency, increased yield, increased rate, and increased utility.

54. The method of claim 44, wherein the chemical reaction comprises denaturing the biomolecule, solubilizing the biomolecule, or a combination thereof.

55. The method of claim 34, further comprising degrading the surfactant after the chemical reaction.

56. The method of claim 55, wherein the surfactant is degraded by contact with an acidic solution.

57. The method of claim 34, wherein the surfactant is represented by formula II:



(II)

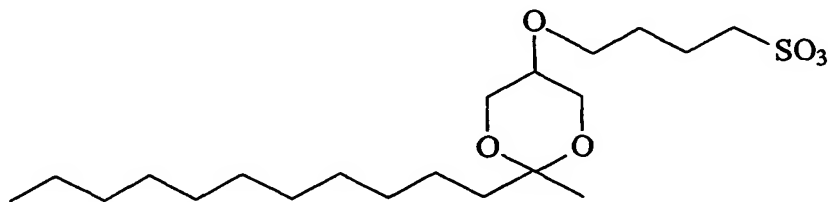
in which

R₆ is alkyl;

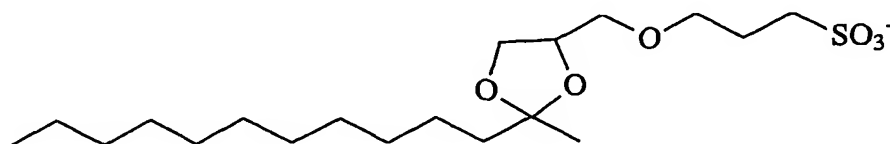
R₇ is selected from -OSO₃⁻, -R₄OSO₃⁻, -R₄OR₅SO₃⁻, and -OR₅SO₃⁻,

wherein R₄ and R₅ are each, independently, lower alkyl.

58. The method of claim 34 wherein the surfactant has the following chemical structure:



59. The method of claim 34 wherein the surfactant has the following chemical structure:



60. The method of claim 34 wherein the enhancement of the chemical reaction facilitates on-line automation, separation, mass spectrometric analysis, or a combination thereof.

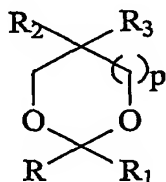
61. The method of claim 34 wherein the chemical reaction may be performed under microscale conditions.

62. The method of claim 45 wherein the digestion occurs in an electrophoretic gel.

63. The method of claim 62 wherein the digestion occurs in the presence of SDS.

5 64. The method of claim 62 wherein the digestion occurs in the absence of SDS.

65. A kit for enhancing a chemical reaction of a molecule comprising:
a surfactant represented by formula I:



(I)

10 in which

p is 0, 1 or 2;

R is alkyl;

R₁ and R₂ are each, independently, hydrogen or methyl; and

R₃ is selected from -OSO₃⁻, -R₄OSO₃⁻, -R₄OR₅SO₃⁻, and -OR₅SO₃⁻,

15 wherein R₄ and R₅ are each, independently, lower alkyl; and instructions
for use.

66. The kit of claim 65, wherein the molecule is a biomolecule.

20 67. The kit of claim 66, further comprising analyzing the biomolecule following the
chemical reaction.

68. The kit of claim 66, wherein the biomolecule is contained in a biological sample.

25 69. The kit of claim 68, wherein the biological sample is selected from the group
consisting of inclusion bodies, biological fluids, biological tissues, biological matrices,
embedded tissue samples, and cell culture supernatants.

70. The kit of claim 66, wherein the biomolecule is selected from the group
30 consisting of a protein and a peptide.

71. The kit of claim 70, wherein the biomolecule is selected from the group consisting of a lipophilic protein, a receptor, a proteolytic protein, and a membrane-bound protein.

5 72. The kit of claim 67, wherein the analysis is selected from the group consisting of solid phase extraction, solid phase micro extraction, electrophoresis, mass spectrometry, liquid chromatography, liquid-liquid extraction, membrane extraction, soxhlet extraction, precipitation, clarification, electrochemical detection, staining, elemental analysis, Edmund degradation, nuclear magnetic resonance, infrared analysis, flow
10 injection analysis, capillary electrochromatography, ultraviolet detection, and combinations thereof.

73. The kit of claim 72, wherein the mass spectrometry is surface desorption ionization mass spectrometry.

15

74. The kit of claim 73 wherein the surfactant is not degraded prior to analysis.

75. The kit of claim 65, wherein the reaction comprises chemical digestion, chemical alteration, or a combination thereof.

20

76. The kit of claim 75, wherein the reaction comprises chemical digestion.

77. The kit of claim 76, further comprising contacting the biomolecule with a protease, CNBr, or hydroxylamine.

25

78. The kit of claim 77, wherein the protease is immobilized.

79. The kit of claim 77, wherein the protease is selected from the group consisting of Trypsin, Chymotrypsin Lys-C, Glu-C (V8 protease), AspN, Arg-C, S. Aureus,
30 Clostripain, Pepsin, and Papain.

80. The kit of claim 73, wherein the reaction comprises chemical alteration

81. The kit of claim 80, wherein the chemical alteration is selected from the group
35 consisting of alkylation, reduction, and a combination thereof.

82. The kit of claim 65, wherein the enhancement of the chemical reaction comprises a favorable chemical property.

83. The kit of claim 82, wherein the favorable chemical property is selected from the group consisting of a more complete reaction, increased efficiency, increased yield, increased rate, and increased utility.

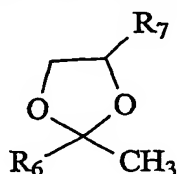
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84. The kit of claim 75, wherein the chemical reaction comprises denaturing the biomolecule, solubilizing the biomolecule, or a combination thereof.

85. The kit of claim 65, further comprising degrading the surfactant after the
10 chemical reaction.

86. The kit of claim 85, wherein the surfactant is degraded by contact with an acidic solution.

15 87. The kit of claim 65, wherein the surfactant is represented by formula II:



(II)

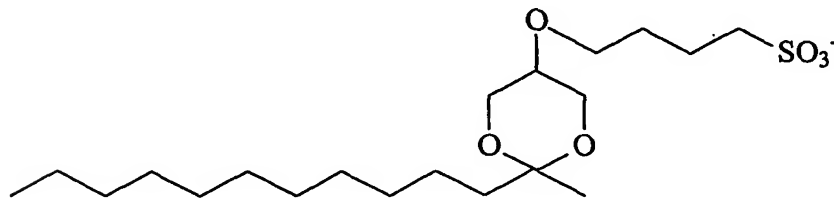
in which

R₆ is alkyl;

R₇ is selected from -OSO₃⁻, -R₄OSO₃⁻, -R₄OR₅SO₃⁻, and -OR₅SO₃⁻,

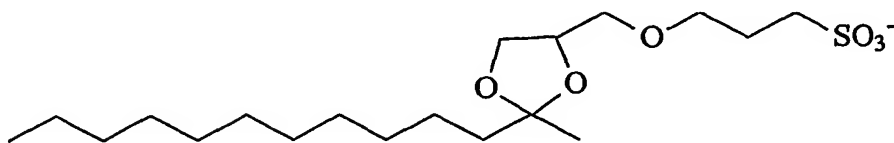
20 wherein R₄ and R₅ are each, independently, lower alkyl.

88. The kit of claim 65 wherein the surfactant has the following chemical structure:



25

89. The kit of claim 65 wherein the surfactant has the following chemical structure:



5 90. The kit of claim 65 wherein the enhancement of the chemical reaction facilitates on-line automation, separation, mass spectrometric analysis, or a combination thereof.

91. The kit of claim 65 wherein the chemical reaction may be performed under microscale conditions.

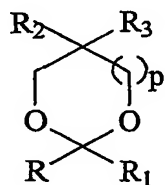
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92. The kit of claim 76 wherein the digestion occurs in an electrophoretic gel.

93. The kit of claim 92 wherein the digestion occurs in the presence of SDS.

15 94. The kit of claim 92 wherein the digestion occurs in the absence of SDS.

95. A method of capturing a lipophilic compound comprising contacting a lipophilic compound with a surfactant represented by the formula:



20

in which

p is 0, 1 or 2;

R is alkyl;

R₁ and R₂ are each, independently, hydrogen or methyl; and

25 R₃ is selected from -OSO₃⁻, -R₄OSO₃⁻, -R₄OR₅SO₃⁻, and -OR₅SO₃⁻,

wherein R₄ and R₅ are each, independently, lower alkyl; and degrading the surfactant to produce a hydrophobic compound; to thereby capture the lipophilic compound.

96. The method of claim 95, wherein the lipophilic compound is contained in a sample.

97. The method of claim 96, wherein the sample comprises a biological sample.

5

98. The method of claim 95, wherein the product of degradation is compatible with mass spectrometric detection, high performance liquid chromatography analysis, and with protease activity.

10 99. The method of claim 95, wherein the lipophilic compound is a protein fragment or peptide.

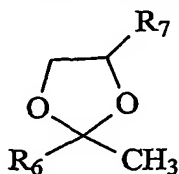
100. The method of claim 99, wherein the protein fragment is generated by chemical digestion or a combination of chemical alteration and chemical digestion.

15

101. The method of claim 100, wherein the wherein the protein fragment or the peptide is the product of a protein that has been digested by contact with a protease and the surfactant of formula I.

20 102. The method of claim 95, wherein the surfactant is degraded by contact with an acidic solution.

103. The method of claim 95, wherein the surfactant is represented by formula II:



(II)

25

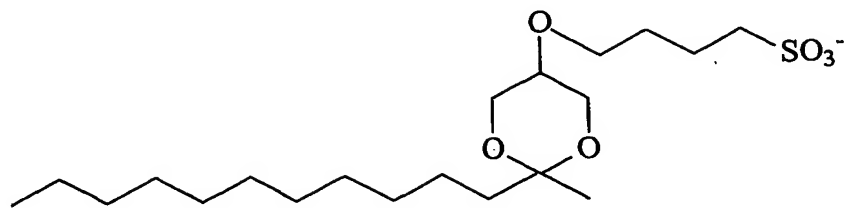
in which

R₆ is alkyl;

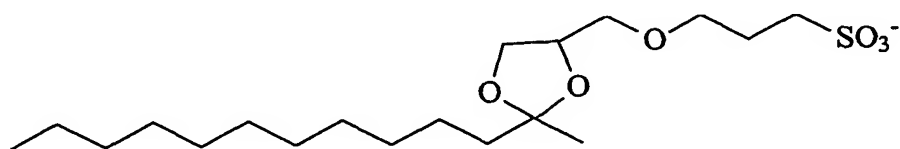
R₇ is selected from -OSO₃⁻, -R₄OSO₃⁻, -R₄OR₅SO₃⁻, and -OR₅SO₃⁻,

wherein R₄ and R₅ are each, independently, lower alkyl.

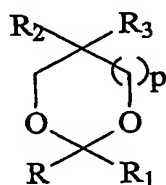
104. The method of claim 95 wherein the surfactant has the following chemical structure:



5 105. The method of claim 95 wherein the surfactant has the following chemical structure:



10 106. A method for enhancing surface desorption ionization analysis of a molecule comprising: contacting the molecule with a surfactant represented by the formula:



in which

15 p is 0, 1 or 2;

R is alkyl;

R_1 and R_2 are each, independently, hydrogen or methyl; and

R_3 is selected from $-\text{OSO}_3^-$, $-\text{R}_4\text{OSO}_3^-$, $-\text{R}_4\text{OR}_5\text{SO}_3^-$, and $-\text{OR}_5\text{SO}_3^-$,

wherein R_4 and R_5 are each, independently, lower alkyl; to thereby analyze the sample
20 by surface desorption ionization.

107. The method of claim 106, wherein the molecule is a biomolecule.

108. The method of claim 106 wherein the surface desorption ionization is MALDI-
25 MS.

109. The method of claim 106 wherein the surface desorption ionization is DIOS.

110. The method of claim 106, wherein the surface desorption ionization is SELDI.

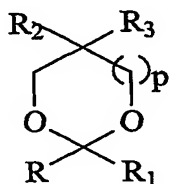
5

111. The method of claim 106, wherein the surfactant is not degraded prior to analysis,

112. The method of claim 106, wherein the surfactant is degraded prior to analysis,

10

113. A method for enhancing chemical digestion of a biomolecule comprising:
contacting the molecule with a digestive enzyme and a surfactant represented by formula
I:



(I)

15

in which

p is 0, 1 or 2;

R is alkyl;

R₁ and R₂ are each, independently, hydrogen or methyl; and

R_3 is selected from $-\text{OSO}_3^-$, $-\text{R}_4\text{OSO}_3^-$, $-\text{R}_4\text{OR}_5\text{SO}_3^-$, and $-\text{OR}_5\text{SO}_3^-$,

20

wherein R₄ and R₅ are each, independently, lower alkyl;

to thereby enhance the chemical digestion of the molecule.

114. The method of claim 113, wherein the biomolecule is a protein.

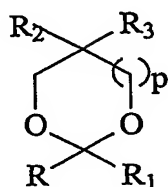
25

115. The method of claim 114, wherein the protein is selected from the group consisting of bovine serum albumin, lysozyme, ovalbumine, myoglobin, ubiquitin, and bacteriorhodopsin.

30

116. The method of claim 114, wherein the protease is selected from the group consisting Trypsin, Chymotrypsin Lys-C, Glu-C (V8 protease), AspN, Arg-C, S. Aureus, Clostripain, Pepsin, and Papain.

117. A kit for enhancing chemical digestion of a biomolecule comprising: a surfactant represented by formula I:



(I)

in which

p is 0, 1 or 2;

R is alkyl;

R₁ and R₂ are each, independently, hydrogen or methyl; and

R₃ is selected from -OSO₃⁻, -R₄OSO₃⁻, -R₄OR₅SO₃⁻, and -OR₅SO₃⁻,

wherein R₄ and R₅ are each, independently, lower alkyl; and instructions

for use.

118 The kit of claim 117 further comprising a digestive enzyme.

119 The kit of claim 118, wherein the digestive enzyme is a protease.

120 The kit of claim 117, wherein the biomolecule is a protein.

121 The kit of claim 120, wherein the protein is selected from the group consisting of bovine serum albumin, lysozyme, ovalbumine, myoglobin, ubiquitin, and bacteriorhodopsin.

122 The kit of claim 119, wherein the protease is selected from the group consisting of Trypsin, Chymotrypsin Lys-C, Glu-C (V8 protease), AspN, Arg-C, S. Aureus, Clostripain, Pepsin, and Papain.